The Industrial Revolution
Big History of Our Planet
– Threshold 8
Summary: On the eve of the ‘Industrial Revolution’

- Two great Malthusian cycles before 1700 CE:
  - The ‘post-classical’ cycle: 600-1450
  - The ‘early modern’ cycle: 1450-1700

- What changed?
  - Commerce spread
  - Globalization: networks of exchange now global
  - Capitalism: affecting societies everywhere
  - Europe:
    - Now at the centre of global networks of exchange
    - New ideas beginning to take hold

- What didn’t change?
  - In 1700 traditional empires were still dominant
  - Most people still lived as traditional peasants
  - The ‘Modern Revolution’ had not yet started
This lecture: The Industrial Revolution

The moment of breakthrough:
From c. 1800 growth/innovation takes off:
1. ‘Industrial Revolution’ : An Overview
2. 1st Industrial Revolution in Britain:
   A triple revolution in
   1. Social relations (1st truly capitalist society?)
   2. Agriculture (capitalism → rapid innovation)
   3. Industrial production (capitalism → rapid innovation)
A shift in the Geography of Economic Power

- Hub Regions of Era of Agrarian Civilizations
- New Hub Region of Modern Era
Look at China & India
Look at Italy, France & Britain
Look at the USA
The Industrial Revolution: An Overview

SHIFTS OF LEADERSHIP WITHIN THE INDUSTRIALIZED WORLD: From Britain, to W. Europe and then to the USA

INCREASING MILITARY & POLITICAL POWER OF THE NEW HUB REGION:

– By 1800: States of the N. Atlantic region had military and/or political/economic control of c. 35% of the earth’s surface

– By 1914: They had military and/or political/economic control of c. 84% of the earth’s surface

• IMPERIALISM!
The Spread of Industrialization

1st Wave: Late 18th Century

O = Newly Industrialized Regions
The Spread of Industrialization

2nd & 3rd Waves: Early-Mid 19th Century

\[ \text{O} = \text{Already Industrialized Regions} \]

\[ \text{O} = \text{Newly Industrialized Regions} \]
The Spread of Industrialization

4th Wave: Late 19th-early 20th Century

= Already Industrialized Regions
= Newly Industrialized Regions
The Spread of Industrialization
5th Wave: Late 20th Century

〇 = Already Industrialized Regions
〇 = Newly Industrialized Regions
Invented in 1793, by Eli Whitney to clean seeds and other materials from cotton fibres.

Now 1 person could do what had taken 50 people previously. The cotton industry was revolutionized.

Giving slavery another 50 years!
So why start with Britain?

1. Where the industrial revolution first had a fundamental impact:

2. Contemporaries first noticed the change in Britain:
   
   In 1837, the French Revolutionary, Blanqui, described changes in Britain as an ‘Industrial Revolution’

3. Origins of the Industrial Revolution have been studied most carefully in Britain
The British Industrial Revolution: 3 revolutions in one

1. Social Structure → a capitalist society
2. Agriculture → capitalist agriculture (i.e. agriculture as a business)
3. Industry → capitalist industry

• Result? Sharp increases in innovation and productivity
British society in 1700 was very capitalistic

- **Peasants → Wage-earners:**
  - Enclosures → 50% of people had too little land to support themselves → earned wages → involved in markets → often move to towns

- **Urbanization:**
  - 10% of Britain’s population in London alone

- **Incomes:**
  - Half of all incomes from industry, commerce, rents and services

- **Elite groups:**
  - Most landlords treated their estates as businesses

- **Government:**
  - Drew most revenues from commerce, actively protected commerce and colonies, if necessary with navies and armies
Briton at Center of World Markets: Mid-Late 18th century

- Areas controlled by Britain
- Trade routes dominated by Britain
An Agricultural Revolution:
Two ‘ideal types’ of agriculture

- **Traditional Farming: 90% on land**
  - Small farms, using family labor
  - Self-sufficiency: peasants produce own food, do not buy
  - Elite groups skimmed off surpluses (‘Tributes’)
  - Farming not treated as a business: The goal was to feed a family and pay taxes. It was not worth producing more.
  - INNOVATION is not vital, and usually seen as too risky

- **Capitalist farming: 10% on land**
  - Farms large: Landlords lease to ‘farmers’ to work land profitably
  - Farmers use wage labor
  - Most produce marketed
  - Profits are the goal, not eating. Farmers must produce as much as possible and sell cheaply.
  - INNOVATION is vital to success
Capitalist Agriculture

- Large-scale
- Based on wage labor
- Aimed mainly at making profits, not at feeding the farmer
- Often based on a single crop
- Innovation is vital to success
British farming changed fast: from traditional to capitalistic

- 1700 and 1800: Av. size of farms rose and the number fell. Why?
  - Enclosures: *Traditional peasants squeezed out*
    - Became wage-earners
    - Had to buy the food they once produced themselves
  - Landlords bought their land
    - Began to treat farming like a business
    - Hired former peasants as wage laborers
    - Sold food to the growing numbers of wage-earners

- Similar changes are occurring in many third world countries today
The impact of commercial agriculture on productivity?

- Techniques for raising productivity had been around for a long time:
  - Breeding superior livestock
  - Planting fallow crops such as legumes or turnips
  - Improved forms of irrigation or drainage
  - Introducing improved machinery

- Only commercial farmers had the incentive and capital to introduce innovations →
  - As farming becomes capitalistic innovation rises sharply
The Results of innovation? Agricultural Productivity soared

• 1700-1850
  – Total production of British agriculture $\times$ 3.5
  – Nos. employed fell from 61% to 29% of population i.e. 30% of the population now fed the other 70%
  – More wage earners $\rightarrow$ a rapidly growing market for agricultural produce

• By 1840, British agriculture extraordinarily productive
Industrial Revolution: Two ‘ideal types’ of industry

• Traditional:
  – Mostly in households or small workshops
  – Small scale
  – **INNOVATION** unusual (sometimes frowned upon)

• Capitalist:
  – Most industrial production in large factories
  – Production large-scale
  – **INNOVATION** vital to success
Traditional manufactures had changed little in several millennia.

Pinturicchio, ‘The Return of Ulysses’ (1509), set in Siena, in Italy.

Portrays a typical traditional workshop based in a domestic household.
Modern, Capitalist forms of Production

- **Modern** methods of production:
  - On a larger scale
  - Depended mainly on wage labor
  - Produced in large amounts
  - Depended on innovation to survive
A 19th century steel factory

Modern industrial workplaces are more often large scale, depend on large-scale production, and technological innovation.
18th century Britain: entrepreneurs start investing in capitalist industry: Why?

1. **Agricultural Revolution** cheapens labor costs →
   - More people seek wage work
   - Food cheaper

2. **Pro-commercial** government protects entrepreneurs
   - Protects markets in the colonies
   - Creates an efficient banking system (‘Bank of England’)

3. **Geography:** The hub of new ideas & global markets

Result? **An Ideal situation for entrepreneurs:**
   - Labor costs falling
   - Demand rising on internal and global markets
   - Capital cheap
   - New ideas abundant
Two crucial sectors of manufacturing

- **Textiles:**
  - After agriculture, the second largest sector in most pre-industrial societies

- **Coal & Steam:**
  - Coal was vital because Britain was running out of wood, the main fuel in pre-modern societies
First introduced in 1769 by Richard Arkwright.

Powered by the drive wheel at the bottom, which can be driven by water power or steam power.
An early American textile factory, using steam engines
The Watt Steam Engine: key to the profitable exploitation of fossil fuels
Factories also raised productivity

• By bringing many workers together in large ‘factories’

• Labor Discipline could be increased

• More efficient methods could be introduced

• All machines could be powered by a single ‘prime mover’ (e.g. a watermill or steam engine)
Josiah Wedgwood (1730-95), established the first industrial potteries, at Stoke-on-Trent in Britain. His goods were sold to middle class consumers as well as to the wealth. (Wedgwood was the grandfather of Charles Darwin.)
Steam communications transformed industry

A US factory making woodworking machines: 1880

http://www.scientificamerican.com/slideshow.cfm?id=factories-look-at-manufacturing-over-years-scientific-american-archive
Just to know more...

What is the world’s strongest engine for
• Aeroplane?
• Rocket?
• Car?
• Ship?

How are they comparing with James Watt’s steam engine?
The Spread of Industrialization
1st Wave: Late 18th Century

O = Newly Industrialized Regions
The 1st Wave: late 18th c.

- Mainly confined to Britain
- Main new technologies:
  - Coal mining
  - Steam engines
  - Textile production
- Generally: innovation accelerates in many areas
The Spread of Industrialization

2nd & 3rd Waves: Early-Mid 19th Century

O = Already Industrialized Regions
O = Newly Industrialized Regions
The 2\textsuperscript{nd} Wave: early 19\textsuperscript{th} c.

- Railways (steam engines on wheels)
  - Made land communication \textbf{faster}, and \textbf{cheaper}
  - \textbf{Increased demand} for iron and coal
  - Attracted huge sums of \textbf{investment capital}
Stephenson’s “Rocket” 1829
Particularly in large countries, steam revolutionized transportation.

Willamette river, Oregon
THE BIG HISTORY

The 3\textsuperscript{rd} Wave: Mid 19\textsuperscript{th} c.

• New Technologies:
  – Chemicals (particularly dyes and artificial fertilizers)
  – Electricity
  – Steel making
  – Agriculture more industrialized (partic. in USA)
  – Warfare more industrialized

• New approaches:
  – Science applied to production (beginning in Germany)
  – Mass production using interchangeable components (mainly US)
Industrializing war

The ‘productivity’ of killing machines increased.

The ‘Gatling gun’, developed during the American Civil War, increased the number of people who could be killed by a single operator.
Edison’s light bulb (1879)

A revolutionary innovation, which, in effect, lengthened the hours of daylight for the first time in human history.

X-Ray of a modern light bulb
Edison and the Phonograph (1870s)

For the first time, people could talk to each other instantaneously over large distances.
The Spread of Industrialization

4th Wave: Late 19th-early 20th Century

= Already Industrialized Regions
= Newly Industrialized Regions
The 4\textsuperscript{th} wave: late 19\textsuperscript{th} – early 20\textsuperscript{th} c.

- The USA $\rightarrow$ largest industrial economy
- Russia & Japan start rapid industrialization
- New Energy Sources:
  - Oil
- New technologies:
  - Internal Combustion engine
  - Airplanes
- New methods:
  - Large corporations combining production and marketing
  - Mass production on assembly lines
Russia: Oil, Iron & steel, railways

Baku Oil Wells 1891

The Trans-Siberian Railway
Steam still dominated early in the 20th century.
Internal Combustion Engine

The engine from a 1925 Morris family car
One of the first ‘assembly lines’

Introduced by Henry Ford in 1913 to mass produce the first cars aimed at a mass market.

Each worker performs one special task, which speeds up the process of assembly, in accordance with the principle of the ‘division of labor’ enunciated by the economist, Adam Smith.
What rolled off the Ford assembly lines: The Model T
Readings

• Adam Smith “Wealth of Nation”
• Karl Marx “Alienated Labour”
Germany and the US catching up: Output as % of global total: 1750-1980

Based on Table 20
Industrialization and Government

• How did the Modern Revolution transform governments?

• Traditional Agrarian States:
  – Economic Base: peasant agriculture ➔ ‘tributes’
  – Functions: tributes & war ➔ ‘violence managers’
  – Impact on citizens: little interest in daily lives of their subjects, remote from village life

• Modern Industrial States:
  – Economic Base: entrepreneurial, market economies
  – Functions: economy vital ➔ ‘economy managers’
  – Impact on citizens: States ➔ more intrusive
    • Wage earners need states to protect their rights, maintain markets, etc.
    • Modern societies too complex to be ruled by force alone; states need to work with their citizens
Emergence of the first ‘modern’ states

- Political changes first apparent in U.S.A. and France, late 18th century. Why?
  - new states, remade during revolutions
  - adapted to new economic and military conditions

- Shaped by new, industrialized warfare:
  - More resources for war
  - New technologies → war more destructive & costly
  - To survive, modern states need:
    - Wealthy, innovative economies
    - Active support of subjects
The increasing scale of warfare

1815: The Battle of Waterloo, one of the bloodiest battles up to that time
The American Civil War: the first ‘industrial’ war

Victory depended on industrial output

A confederate mortar mounted on a flat car

1863: The Battle of Gettysburg
Mobilizing resources: Economic management

To win wars, states needed large, productive economies ➔

• They had to encourage innovation/growth

• Managing capitalist economies
  – Law & Order: They had to protect property and business (law & policing)
  – Protecting Entrepreneurs: They had to protect property rights
  – Encourage innovation: They had to support growth but avoid interfering too much
Mobilizing support: Power and Democracy

States needed the *active* support of their citizens

– i.e. ‘*power from below*’
– Not just raw coercion (i.e. ‘*power from above*’)

• New ways of mobilizing support:
  1. **Democracy** → a sense of participation
  2. **Nationalism** → a sense of belonging
  3. **Services** → a sense of getting something back
    • Law and Order
    • Education
    • Health care
‘Ideal types’ of two cultural worlds:

- Traditional cultures:
  - Most people peasants:
  - Few needed education or literacy
  - Religious and magical thinking dominate thinking

- Modern cultures:
  - Huge variety of different ways of earning a living
  - Innovation → basic skills constantly change
  - Literacy and education essential for wage-earners
  - Scientific knowledge vital for economic survival
Changes in ‘Mass Culture’

• Urbanization:
  – More people in towns, supported by wage labor

• Literacy & Education:
  – Employers needed skilled employees
  – Governments introduce mass education
Science and innovation became closely linked.

By the end of his life, Edison had patents on more than 1,000 inventions, including the light bulb and the telephone.
Innovations in communications stimulated ‘Collective Learning’

- Railways & Steamships
- Telegraph
- Newspapers
- Telephone
Pt. 4: The Dark Side: Growing Inequality & a ‘Third World’

- By 1860 the impact of industrialization is already global
- Outside the core zone, the impact is largely destructive
- Industrialization ...
  - Undermined Traditional States:
  - Undermined Traditional Lifeways:
The growing Economic & Military Imbalance

- Atlantic hub region → center of the global economy
- Other regions & traditional agrarian empires weakened
1793: Britain sends an embassy to the Qing Emperor, Qianlong

The Embassy of British Ambassador George McCartney
40 years later

In 1839, British gunboats (iron-clad and steam-powered) bombard Canton to force China to permit sale of British-imported opium from India.
Like all major transitions, the ‘Modern Revolution’
  – Created much that was new
  – Destroyed traditional lifeways, and caused immense suffering

By 1900, the world was divided into two worlds:
  – Regions that had undergone the Modern Revolution
  – Regions that had not

The ‘3rd’ World: created in the late 19th century
Summary

• 4 waves of industrialization up to 20th century
  – Industry spread to new regions
  – Innovations: railways, chemicals, electricity, oil, etc.

• Political Changes:
  – More resources forced states to become more managerial
  – States began to exert greater control over individual citizens
  – States sought support through democracy and/or nationalism

• Cultural Changes:
  – Literacy and education became vital for most people
  – Science began to challenge Religion as the source of ‘truth’

• Creation of the Third World:
  – Once successful societies find their economies and states undermined by the growing power of industrial states